

1 POWERED ANTITHROMBOTIC FOOT MOBILITY DEVICE
2 WITH THERAPEUTIC MASSAGE
3

4 The application is a continuation-in-part of Serial Number
5 10/021,219, filed October 29, 2001, entitled "Powered
6 Antithrombotic Foot Mobility Device", which is hereby
7 incorporated by reference herein in its entirety.
8

9 BACKGROUND OF THE INVENTION
10

11 1. Field of the Invention

12 This invention relates broadly to exercise devices. More
13 particularly, this invention relates to exercise devices which
14 promote circulation in the lower extremities by movement of the
15 foot about a pivot and by providing a therapeutic massage.
16

17 2. State of the Art

18 Deep vein thrombosis (DVT) refers to the formation of a
19 thrombus (blood clot) within a deep vein, commonly in the thigh
20 or calf. The blood clot can travel to the lungs, resulting in
21 pulmonary embolism, a potentially life-threatening condition.
22

23 DVT occurs when the flow of blood is restricted in a vein,
24 and can be caused by poor circulation because of problems such
25 as heart disease, a recent heart attack or stroke, varicose
26 veins, or from inactivity or prolonged bed rest. Recently, a
27 lot of attention has been focused on DVT developed during long

1 airplane flights and deaths resulting therefrom. In fact, DVT
2 has been dubbed 'economy class syndrome' because the less
3 expensive seats in a plane have less leg room, limited leg
4 movement. However, DVT is not confined to economy class or to
5 long haul flights.

6
7 In view of current and impending lawsuits by passengers
8 with respect to DVT, airlines have become proactive in trying to
9 prevent the condition and are now directing passengers to get up
10 and walk around the airplane cabin at least once an hour to
11 increase blood circulation. However, flights are subject to
12 meal service and turbulence which limit the amount of time
13 available for passengers to exercise their legs. Moreover,
14 flights are crowded and it is not feasible for all the
15 passengers to walk through the narrow aisles in the cabin.

16
17 As a response, a number of devices are being promoted to
18 increase blood circulation while a passenger remains seated.
19 For example, the LYMPHA-PRESS® SKY WALKER™ device by Mego Afek
20 of Kibbutz Afek, Israel, is a portable, foldable exercise device
21 operated from a seated position. The device includes two foot
22 pedals which are not subject to any resistance other than
23 minimal friction forces. When the user wants to increase
24 circulation, the pedals can be easily moved by the feet of a
25 user in a pedaling motion. The simple pedal movement of the
26 user's feet effects contraction of the calf muscles which

1 assists in moving venous blood back to the heart, augmenting
2 arterial blood inflow and preventing thrombosis.

3
4 However, this and similar devices have a common drawback
5 when used for the purpose of preventing DVT on long airplane
6 flights; they require too much effort. Even the SKY WALKER™
7 device, which offers substantially no resistance, requires the
8 user to concentrate on the movement of the feet. That is, if
9 the user concentrates on the in-flight movie or a magazine, it
10 is easy to forget to continue to pedal and DVT can result.

11
12 U.S. Patent No. 6,217,488 to Bernardson discloses another
13 lower leg exerciser which includes a base, foot pedals which
14 rock along a pivot relative to the base, and a motor adapted to
15 rock the pedals back and forth. When feet are placed on the
16 pedals, the feet are rocked automatically and blood circulation
17 in the legs is increased. However, the Bernardson device has
18 several drawbacks. First, the rocking movement of the feet
19 causes the knees to move up and down. This motion is not suited
20 to airplane travel, as the room in front of a seat is limited,
21 and once the user's feet are raised and placed on the device,
22 the rocking motion may cause the user's knees to contact the
23 back of the chair in front, may cause interference with a tray
24 table, or may be annoying if, e.g., trying read a book held on
25 the lap. A second drawback is that the Bernardson device cannot
26 be reconfigured to a smaller size for increased portability.

1 My previously incorporated prior application, which is
2 parent hereto, describes a foot mobility device having a body,
3 two pedals rotatable about a common axis preferably in
4 opposition to each other and relative to the body, and a motor
5 drive assembly coupled to the pedals. The feet of a user are
6 placed on the pedals, and the motor drive assembly is powered to
7 cause movement of the pedals even while the user is completely
8 passive; i.e., without any active participation by the user.
9 Moreover, the sensation received by the use, rather than being
10 one of typical "exercise", is massage-like and therapeutic, all
11 while providing the same benefit of increased blood circulation
12 due to contraction and relaxation of the calf muscle. Moreover,
13 the foot mobility device may be moved between an open
14 configuration adapted for use of the device and a collapsed
15 configuration having a low profile and adapted for storage and
16 portability.

17
18 According to one embodiment, the foot mobility device
19 includes a generally vertically oriented body, two foot pedals
20 hingedly coupled on either side of the body to rotate
21 substantially ninety degrees relative to the body between a
22 closed position in which each foot pedal is substantially
23 parallel to the body and an open position in which each foot
24 pedal is substantially perpendicular to the body. In the open
25 position, the pedals are adapted to cause feet placed thereon to
26 rotate about the ankle joint.

1 According to other embodiments, the foot mobility device
2 includes a preferably flat base, two pedals rotatable about a
3 heel pivot, and a motor mechanism which rotates the pedals. The
4 motor mechanism is movable from a first position in which it
5 lies against the base to an upright second position in which it
6 is adapted to move the pedals. The pedals can be configured to
7 lie flat against the base for storage and portability. In
8 addition, the pedals can preferably be disengaged from the motor
9 drive so that the device can be used as an active exercise
10 device and also to facilitate moving the pedals for folding the
11 device in a highly portable configuration.

12 13 SUMMARY OF THE INVENTION 14

15 It is therefore an object of the invention to provide a
16 foot mobility device which moves the feet in a manner which
17 limits knee movement.

18
19 It is another object of the invention to provide a foot
20 mobility device which requires no effort on the part of the
21 user.

22
23 It is an additional object of the invention to provide a
24 foot mobility device which is portable.

25
26 It is also an object of the invention to provide a foot
27 mobility device which has a low profile.

1 It is still another object of the invention to provide a
2 foot mobility device which has a collapsed configuration.

3
4 It is a further object of the invention to provide a foot
5 mobility device which includes foot massaging capability.

6
7 It is still another object of the invention to provide a
8 foot mobility device which operates without complex motors and
9 gears.

10
11 It is yet another object of the invention to provide a foot
12 mobility device which can be used with one foot alone or in
13 synchronization with both feet.

14
15 In accord with these objects, which will be discussed in
16 detail below, a foot mobility device according to the invention
17 includes a base, a foot rest hingedly coupled to the base, and
18 an inflatable lifting bladder between the base and the foot
19 rest. The lifting bladder is coupled by a valve to a source of
20 fluid pressure. The valve is operable to inflate and deflate
21 the lifting bladder thereby raising and lowering the foot rest
22 without the use of a motor and gear assembly. The foot rest
23 preferably has a massage sock coupled to it. The massage sock
24 contains a plurality of inflatable massage bladders, each being
25 coupled by a valve to a source of fluid pressure, each of the
26 valves being operable to inflate and deflate the massage
27 bladders. Each of the bladders is preferably coupled to a

1 pressure sensor which determines the extent to which the bladder
2 has been inflated/deflated.

3
4 According to a presently preferred embodiment, the source
5 of fluid pressure is an air pump and a compressed air tank
6 coupled to the valves and a pressure sensor. In the presently
7 preferred embodiment, the valves are electrically operable and
8 the pressure sensors produce electrical signals. A control
9 circuit is electrically coupled to the valves, the sensors, and
10 the pump. The control circuit selectively inflates and deflates
11 the bladders according to a cycle which raises and lowers the
12 foot rest and inflates/deflates the massage bladders. The
13 presently preferred control circuit is a microprocessor, ASIC
14 (application specific integrated circuit), PLA (programmable
15 logic array) or similar circuit which will operate the valves to
16 inflate and deflate the bladders to desired pressures
17 (determined by the sensors) according to a programmed regime. A
18 simple regime is to inflate bladders to 2-3 psi for 20-30
19 seconds then deflate to 0 psi in an alternating sequence
20

21 Also according to the presently preferred embodiment, the
22 control circuit is provided with a synchronization link which is
23 used to electrically couple two foot mobility devices (one for
24 each foot) such that they operate in an alternating rhythm.
25

26 The presently preferred massage sock is made of elastic
27 material and provided with a zipper so that it may comfortably a

1 variety of foot sizes. The presently preferred number of
2 massage bladders is seven: two under the heel, two behind the
3 heel, two over the instep, and one under the sole.

4
5 Additional objects and advantages of the invention will
6 become apparent to those skilled in the art upon reference to
7 the detailed description taken in conjunction with the provided
8 figures.

9
10 BRIEF DESCRIPTION OF THE DRAWINGS

11
12 Fig. 1 is a perspective view of the upper front of a foot
13 mobility device according to the invention;

14
15 Fig. 2 is a perspective view of the lower rear of the foot
16 mobility device;

17
18 Fig. 3 is a top plan view of the foot mobility device;

19
20 Fig. 4 is a front side elevational view of the foot
21 mobility device;

22
23 Fig. 5 is a perspective view of two foot mobility devices
24 and a synchronization cable; and

25
26 Fig. 6 is a schematic diagram of the electrical and
27 pneumatic components of the foot mobility device.

1
2 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS
3

4 Turning now to Figs. 1 and 2, a foot mobility device 10
5 according to the invention includes a base 12, a foot rest 14
6 hingedly coupled to the base 12, and an inflatable lifting
7 bladder 16 between the base 12 and the foot rest 14. As
8 described in more detail below with reference to Fig. 6, the
9 lifting bladder 16 is coupled by a valve to a source of fluid
10 pressure and the valve is operable to inflate and deflate the
11 lifting bladder thereby raising (see Fig. 1) and lowering (see
12 Fig. 4) the foot rest 14 without the use of a motor and gear
13 assembly. When the bladder 16 is deflated it collapses into the
14 well 17 in the base 12 permitting the foot rest 14 to lie flush
15 with the base.

16
17 The foot rest 14 preferably has a massage sock 18 coupled
18 to it. The massage sock contains a plurality of inflatable
19 massage bladders which are described in more detail below with
20 reference to Figs. 3, 4, and 6. As seen in Fig. 1, the massage
21 sock 18 has a zipper 20 which facilitates attachment of the sock
22 to the user's foot. Fig. 1 also illustrates a fluid conduit 22
23 for inflating the lifting bladder 16 and a fluid conduit 24 for
24 inflating the massage bladders.

25
26 Fig 2. illustrates the hinge coupling which includes the
27 interleaved members 26 and the hinge pin 28. Fig. 2 further

1 shows that the base 12 has removable access panels 30, 32. The
2 panel 30 exposes a battery compartment 34 for batteries (not
3 shown) to power the control circuit described below. The panel
4 32 exposes operational equipment such as an air pump 36, a
5 pressure sensor 38, and an electrically operated valve 40. An
6 electrical connector 42 is also shown in Fig. 2. This connector
7 is described in more detail below with reference to Figs. 5 and
8 6.

9
10 Referring now to Figs. 3 and 4, the illustrated embodiment
11 of the massage sock 18 includes seven inflatable massage
12 bladders: two under the heel 48, 50, two behind the heel 44, 46,
13 two over the instep 52, 56, and one under the sole 54. Although
14 Fig. 1 suggests that all of the massage bladders are inflated
15 from a single fluid conduit 24, separate conduits may be
16 provided for each bladder. As mentioned above, the base 12 of
17 the foot mobility device 10 includes a control circuit (not
18 shown in Figs. 1-5) which operates the air pump 36 and valve(s)
19 40 to inflate and deflate the bladders according to a programmed
20 regime.

21
22 Turning now to Fig. 5, the foot mobility device 10 is
23 preferably used together with an identical mate. The control
24 circuits of each device 10 are coupled to each other via the
25 electrical connectors 42 and a synchronization cable 60. The
26 cable is provided with two n-pin electrical connectors 62, 64
27 which mate with connectors 42. When two foot mobility devices

1 are operated together, it is advantageous that one act as master
2 and the other as slave. This can be automatically determined by
3 the connectors 62, 64 on the cable 60. For example, one of the
4 connectors 62, 64 can have two of its n-pins jumpered together
5 whereas the other connector does not have any pins jumpered
6 together. The foot mobility device which receives the connector
7 having the jumpered pins will sense the jumpered pins and in
8 response will act as either a master or slave, whichever is
9 predetermined by the circuit designer. When the foot mobility
10 devices act in master-slave relationship, one possible
11 synchronization scheme is that the slave will wait for a signal
12 from the master before starting the regime.

13

14 Referring now to Fig. 6, an exemplary embodiment of a
15 control circuit is illustrated in conjunction with the
16 aforementioned bladders, air pump, valve and sensor. In this
17 embodiment, the air pump 36 is coupled to a compressed air tank
18 37 which feeds a compressed air distribution conduit 39. Each
19 of the bladders is coupled by an electrically operated valve to
20 the conduit 39. For example, the lifting bladder 16 is coupled
21 via conduit 22 to valve 40-0 which is coupled to the conduit 39.
22 The massage bladders 44-56 are similarly coupled via conduits
23 24-1 - 24-7 to valves 40-1 - 40-7 to the conduit 39. Each of
24 the valves is also coupled to an electrical pressure sensor 38-0
25 - 38-7 which monitor the pressure in each of the bladders. The
26 compressed air tank 37 is also coupled to a pressure sensor 38-
27 8. All of the valves and sensors are coupled to a control

1 circuit 70 which is also coupled to the air pump 36, a power
2 supply 72 and a synchronization link 42 (previously referred to
3 an electrical connector).
4

5 The control circuit 70 operates the air pump 36 to fill the
6 air tank 37 and selectively operates the valves to inflate and
7 deflate the bladders according to a cycle which raises and
8 lowers the foot rest and inflates/deflates the massage bladders.
9 The presently preferred control circuit is a microprocessor,
10 ASIC (application specific integrated circuit), PLA
11 (programmable logic array) or similar circuit which will operate
12 the valves to inflate and deflate the bladders to desired
13 pressures (determined by the sensors) according to a programmed
14 regime. A simple regime is to inflate bladders to 2-3 psi for
15 20-30 seconds then deflate to 0 psi in an alternating sequence.
16

17 The circuit shown in Fig. 6 may be considered "deluxe".
18 According to simpler embodiments of the invention, fewer valves
19 and sensors may be provided and bladders may be inflated and
20 deflated in groups, rather than individually. It will also be
21 appreciated that the number of massaging bladders may be greater
22 than or fewer than the seven illustrated bladders. The power
23 supply 72 may be a battery or a group of batteries. The battery
24 may be rechargeable, and an AC adapter may be provided to avoid
25 battery consumption/depletion. The present invention
26 contemplates that the massage sock with massage bladders may be
27 used in conjunction with my earlier device which is disclosed in

1 the parent application or in conjunction with other foot rest
2 lifting means.

3

4 There have been described and illustrated herein
5 embodiments of a powered foot mobility device. While particular
6 embodiments of the invention have been described, it is not
7 intended that the invention be limited thereto, as it is
8 intended that the invention be as broad in scope as the art will
9 allow and that the specification be read likewise. It will
10 therefore be appreciated by those skilled in the art that yet
11 other modifications could be made to the provided invention
12 without deviating from its spirit and scope.